Highlights

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Spin Pumping and Measurement of Spin Currents in Optical Superlattices

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We report on the experimental implementation of a spin pump with ultracold bosonic atoms in an optical superlattice. In the limit of isolated double wells, it represents a 1D dynamical version of the quantum spin Hall effect. Starting from an antiferromagnetically ordered spin chain, we periodically vary the underlying spin-dependent Hamiltonian and observe a spin current without charge transport. We demonstrate a novel detection method to measure spin currents in optical lattices via superexchange oscillations emerging after a projection onto static double wells.

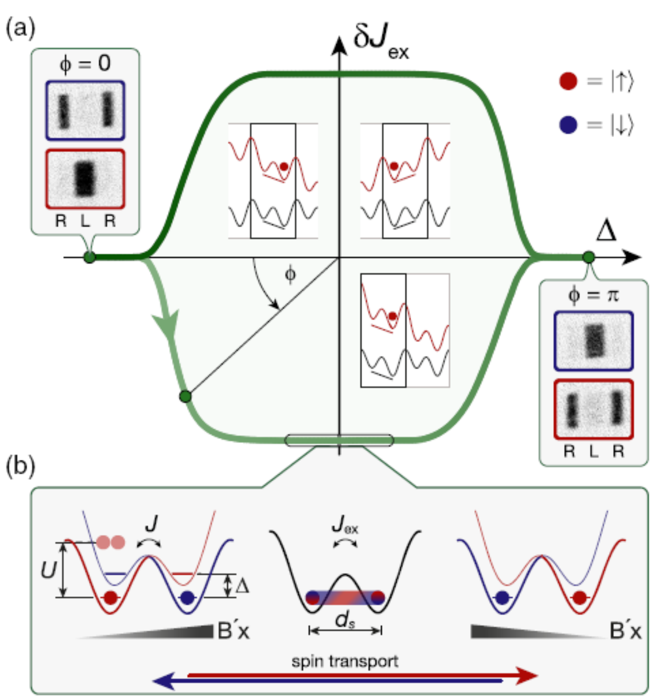

Figure 1. Spin pump cycle. (a) Spin pump cycle (green) in parameter space of spin-dependent tilt Δ and exchange coupling dimerization δJ_{ex}. The path can be parametrized by the angle ϕ, the pump parameter. Between ϕ=0 and π, ↑ and ↓ spins exchange their position, which can be observed by site-resolved band mapping images detecting the spin occupation on the left (L) and right (R) sites, respectively.
(b) Evolution of the two particle ground state in a double well around Δ=0 with tunnel coupling 1/2(J+ δJ), on-site interaction energy U, and spin dependent tilt Δ, as well as the exchange coupling J_{ex}□ $1/2(J+ \delta J)^2/U$ and the lattice constant d_s.